

COST ASSUMPTIONS

FOR CONTAMINANT FACT SHEETS



See related Fact Sheets: Acronyms & Abbreviations; Glossary of Terms; Raw Water Composition; Total Plant Costs; and WaTER Program.

1. COST INDEX DATA

Construction and annual O&M costs were derived from: the WaTER Program; *Estimating Water Treatment Costs*, volumes 1 and 2 of EPA-600/2-79-162a, August 1979; or from manufacturer's product data information. Cost estimates are as of March 2001, are considered accurate within +30% to -15%, and are primarily intended as a guide for comparing alternative water treatment options. More accurate cost estimates can be determined given site specific data and verification of assumptions.

EPA cost index updates as follows:

October 1978 ENR construction cost index = 2581; February 1999 = 5992; March 2001 = 6273.
 October 1978 PPI O&M materials index = 71.6; February 1999 = 130.8; March 2001 = 137.8.
 October 1978 PPI O&M energy cost = \$0.03/kW-hr; February 1999 & March 2001 = \$0.07/kW-hr.
 October 1978 PPI O&M labor cost = \$10/hr; February 1999 = \$30/hr; March 2001 = \$32.5/hr.
 Total annual O&M cost = sum of materials, energy, and labor costs.

The following WaTER Program cost components are based on those used by *ENR* at www.enr.com or 212-512-2000:

<u>Category</u>	<u>2001 Value</u>	<u>Used For</u>
Construction cost index	6,279.45	Manufactured & electrical equipment
Building cost index	3,541.01	Housing
Skilled labor index	5,874.20	Excavation, site work, & labor
Materials index	2,115.65	Piping & valves
Steel cost (\$/cwt)	28.01	Steel
Cement cost (\$/ton)	80.35	Concrete
Materials index	2,115.65	Maintenance materials
Electricity cost (\$/kWhr)	0.07	Power
Labor rate (\$/hr)	32.5	Labor

2. PROCESS ASSUMPTIONS

A. Raw Water Pumps: Costs derived from WaTER program. No. of pumps: 2 centrifugal single stage. Pump efficiency: 75%, motor efficiency 90%. Horsepower based on flowrate.

B. Screening/Straining: Costs derived from manufacturer's product data information. Velocity: 2.5 ft/sec, "Water Supply and Pollution Control," second edition; J.W. Clark, W. Viessman Jr., and M.J. Hammer. Screen size opening: 1/4-inch. 3-, 4-, 5-, and 6-inch diameter screens for flows 0.25, 0.50, 0.75, and 1.0 MGD, respectively. Estimated annual O&M for all flows: \$1,000.

C. Rapid Mix: Costs derived from "Estimating Water Treatment Costs." DT: 30 sec, "Recommended Standards for Water Works," 1982. G value = 900.

D. Polymer Addition: Costs derived from WaTER program. General settling aid: \$1.50/lb. Dosage: 3.0 mg/L.

E. Antiscalant: Costs derived from WaTER program. RO and EDR membrane aid: \$1.50/lb. Dosage: 0.5 mg/L.

F. Dry Alum Coagulation: Costs derived from WaTER program. $Al_2(SO_4)_3$ cost: \$22/100 lbs. Dosage: 230 mg/L.

G. Ferric Sulfate Coagulation: Costs derived from WaTER program. $Fe_2(SO_4)_3$ cost: \$260/short ton. Dosage: 3.0 mg/L.

H1. Lime Softening with Upflow Solids Contact Clarifier: Costs derived from WaTER program. $Ca(OH)_2$ cost: \$340/ton. Dosage: 84.3 mg/L. Two SCC units, each sized for 1/2 total flow. SCC DT: 120 min. SCC O&M G value = 150.

H2. Lime/Soda Ash Softening with Upflow Solids Contact Clarifier: Costs derived from WaTER program. $Ca(OH)_2$ cost: \$340/ton. Na_2CO_3 cost: \$340/ton. $Ca(OH)_2$ dosage: 84.3 mg/L; Na_2CO_3 dosage: 278 mg/L. Two SCC units, each sized for 1/2 total flow. SCC DT: 120 min. SCC O&M G value = 150.

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I. Horizontal Paddle Flocculator: Costs derived from "Estimating Water Treatment Costs." DT: 30 min, "Recommended Standards for Water Works;" 1982. G value = 80.

J1. Circular Clarifier: Costs derived from "Estimating Water Treatment Costs." SLR: 1.0 gal/min/ft², "Recommended Standards for Water Works;" 1982. DT @ 12' sidewall depth: 90 min. Structure is concrete.

J2. Tube Settler: Costs derived from "Estimating Water Treatment Costs." SLR: 2.5 gal/min/ft², "Estimating Water Treatment Costs;" volumes 1 and 2; EPA-600/2-79-162a; August 1979.

K. Dual Media Gravity Filter: Costs derived from WaTER program are based on two concrete basins. Dual media cost: \$938/m³@0.25 MGD; \$815/m³@0.50 MGD; \$701/m³@0.75 MGD; & \$582/m³@1.0 MGD. Dual media FLR: 5.0 gal/min/ft², "Estimating Water Treatment Costs;" volumes 1 and 2; EPA-600/2-79-162a; August 1979. 2 units, each sized for plant capacity. 24 hr wash cycle. Media depth: 1 m. Media volume: 3.2 m³@0.25 MGD; 6.5 m³@0.50 MGD; 9.7 m³@0.75 MGD; 12.9 m³@1.0 MGD. TSS density: 35 g/L. Costs include backwash pump, filter structure, and pipe gallery housing. Backwash piping: 7 ft/sec. Backwash pump: 50' TDH. Maximum backwash rate: 18 gal/min/ft².

L. Chlorine Disinfection: Costs derived from WaTER program. Gaseous Cl₂ cost: \$500/short ton, tank. Dosage (2.5 mg/L) = demand (2 mg/L) + residual (0.5 mg/L). Free chlorine residual of 0.2 - 0.5 mg/L and DT of 30 min for groundwater or 2 hrs for surface water, "Recommended Standards for Water Works;" 1982. Free chlorine residual = chlorine available as HOCl and OCl.

M1. Ion Exchange (Anion): Costs derived from WaTER program. Regeneration cycle: 14 days. Resin cost: \$5,227/m³; 1.0 nominal equivalent/liter of resin for NO₃⁻. NaCl regeneration at 10% strength. Regenerant storage tank included.

M2. Ion Exchange (Cation): Costs derived from WaTER program. Regeneration cycle: 14 days. Resin cost: \$1,819/m³; 1.9 nominal equivalent/liter of resin. NaCl regeneration at 10% strength.

M3. Ion Exchange (Mixed Bed): Costs derived from WaTER program. Regeneration cycle: 14 days. Nuclear grade resin mixture (cation:anion) generally 1:1. Resin cost: \$4,662/m³; 1.9 nominal equivalent/liter (cation) resin; and 1.4 nominal equivalent/liter (anion) resin. NaCl regeneration at 10% strength.

N. Oxidation with KMnO₄ followed by Greensand Filtration: Costs derived from WaTER program, adjusting gravity filtration for greensand filtration. KMnO₄ cost: \$2.10/lb (hopper truck). KMnO₄ dosage: 1.1 mg/L. Total gravel, greensand, and anthracite costs: \$1,750/m³@0.25 MGD; \$1,539/m³@0.50 MGD; \$1,361/m³@0.75 MGD; & \$1,202/m³@1.0 MGD. Greensand loading rate: 5.0 gal/min/ft². 2 units, each sized for plant capacity. 24 hr wash cycle. Media depth: 1 m. Media volume: 3.2 m³@0.25 MGD; 6.5 m³@0.50 MGD; 9.7 m³@0.75 MGD; 12.9 m³@1.0 MGD. TSS density: 35 g/L. Costs include backwash pump and filter structure.

O. Granular Activated Carbon: Costs derived from WaTER program. 6 month bed life.

P. Reverse Osmosis: Total direct capital costs derived from WaTER program and include cleaning system and some pretreatment (antiscalant) filters/chemicals. Operating pressure: 1380 kPa (200 psi). Membrane cost: \$525 per 8" module. Membrane life: 3 years. Product quality: 500 mg/L TDS. Two stage unit operating at 80% recovery with blending. Pretreatment not included.

Q. Microfiltration: Total direct capital costs derived from WaTER program and include cleaning system and some pretreatment filters/chemicals. Design feed pressure: 207 kPa (30 psi). Membrane cost: \$650. Membrane life: 5 years.

R. Electrodialysis Reversal: Costs derived from WaTER program and Ionics, Inc. Unit operates at 80% recovery. Product quality: 500 mg/L TDS. Pretreatment not included.

S. Clearwell: Costs derived from WaTER program. Below ground concrete tank sized based on water source (30 min DT for groundwater or 2 hr DT for surface water) and flowrate.

3. RAW WATER VARIABLES

An assumed raw water composition is shown on the Raw Water Composition Fact Sheet. Following are the only raw water variables used to determine the cost curves:

A. Flow: Costs for each BAT were prepared for flows of 0.25, 0.50, 0.75, and 1.0 MGD.

B. TDS: A TDS of 2,500 mg/L was assumed for all processes; except for RO and EDR where three TDS ranges were estimated at 1,000, 2,500, and 5,000 mg/L.

C. TSS: For dual media gravity and greensand filtration a TSS of 13.0 mg/L was estimated.